A SYNCARID CRUSTACEAN FROM THE KEELE BEDS (STEPHANIAN) OF WARWICKSHIRE

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ABSTRACT. A specimen of *Palaeocaris* cf. *retractata* Calman 1932, collected by Dr. F. Raw from the Upper Carboniferous Keele Beds of the Lickey Hills, Birmingham, is briefly described. This occurrence of the genus (which is best represented in non-marine deposits of Westphalian age) is the youngest known, and enlarges the meagre fauna recorded from the Keele Beds.

DR. F. RAW's find of a rare syncarid crustacean is a welcome addition to the meagre fauna known from the Keele redbeds. The single specimen was collected between 1920 and 1925, from a red 'millet-seed' ironstone in the Keele Beds, on the west flank of Bilberry Hill in the Lickey Hills, south-west of Birmingham (at long. 2° 00′ 13″ W., lat. 52° 22′ 37″ N.). Dr. Raw's own notes show that the specimen was found 'in an excavation in the pathway bordering the hill, adjoining the quarry in the Cambrian quartzite'. On the sketch-map of this region given in Garrett, Hardie, Lawson, and Shotton (1958, fig. 3, p. 15) the locality is situated at a point 9 millimetres due north-east of Lickey church. Dr. Raw had correctly identified the crustacean as 'probably one of the Anaspidacea'. The specimen, BU 733, is deposited in the geology department museum, Birmingham University. Abbreviations in parentheses refer to symbols on text-fig. 1.

Subclass MALACOSTRACA Latreille 1806
Superorder EUMALACOSTRACA Grobben 1892
Order SYNCARIDA Packard 1885
Suborder ANASPIDACEA Calman 1904
Family PALAEOCARIDIDAE Siewing 1955
(*nom. correct.* herein *ex* Palaeocaridae Siewing 1955)
Genus PALAEOCARIS Meek and Worthen 1865
Type species: *P. typus* Meek and Worthen 1865
Palaeocaris cf. *retractata* Calman 1932

Plate 68, fig. 8; text-fig. 1

Body. The specimen is preserved in low relief, but has been crushed obliquely on to its left side, making the body appear unusually deep. Details of the head and anterior limbs are not preserved and the end of the sixth abdominal segment and the telson are missing.

The length from the front of the head to the broken-off end of the sixth abdominal segment is 11·8 mm. The head is 1·3 mm. long, but has been crushed and filled with ?kaolinite obscuring any morphological detail. The thorax is 6·0 mm. long and comprises eight smooth segments. As may be seen from Pl. 68, fig. 8, and text-fig. 1, the small first segment (I) wedges out ventrally only 0·7 mm. below the dorsal border of the head. The fifth thoracic segment (V) is noticeably shorter (0·70 mm.) than the other thoracic segments (0·75–0·90 mm.). Tergal folds are present on all segments except the

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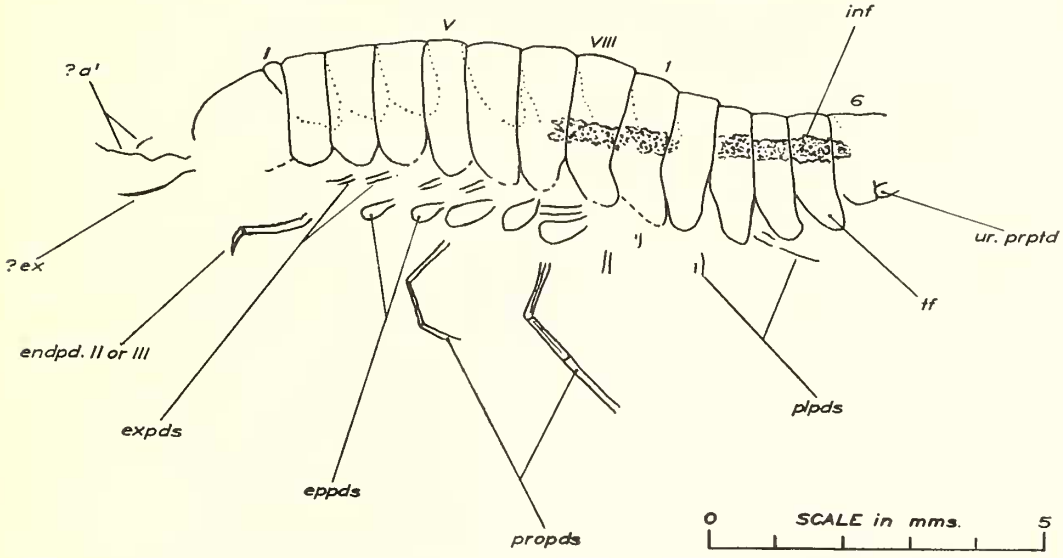
last abdominal (6), but they are better developed on the posterior thoracic and abdominal segments. The abdomen is 4·5 mm. long and composed of five smooth segments *c.* 0·6 mm. long and a longer sixth, pre-telson segment (6) of which 1·1 mm. is preserved.

Appendages. Traces of two segmented flagella and a flattened structure in front of the head are doubtfully suggested from their position to be an antennule (a^1) and the exopodite (or scale) of an antenna (?ex). No other cephalic appendages are visible.



TEXT-FIG. 1. Outline drawing of *Palaeocaris* cf. *retractata* Calman, BU 733. ?a^1, antennule; ?ex, exopodite of antenna; eppds, possibly pereiopod epipodites; endpd II or III, endopodite of second or third pereiopod; propds, propodites of pereiopod endopodites; expds, traces of pereiopod exopodites; plpds, traces of pleopods; tf, tergal fold; ur.prtpd, protopodite of uropod; inf, intestine infilling; I–VIII, thoracic segments; 1–6, abdominal segments; dotted lines indicate impressions of tergal folds on other side of body.

The endopodite of the second or third pereiopod (endpd II or III) has fortunately been preserved and is seen to be no stouter than the endopodites of the other thoracic limbs. The 'knee' or main flexure of the thoracic endopodites is only preserved in two limbs. Following Calman (1932, p. 539), the segment proximal to the knee is taken as the meropodite and hence the two distal segments discernible are the carpopodite and the propodite (propd). Traces of the exopodites of the pereiopods are present but no details of segmentation can be discerned. Immediately ventrad of the last five thoracic segments and exopodites are five concave, oval structures (eppds), which may represent epipodites (see discussion below). Only traces of pleopods are discernible. The pre-telson segment (6) bears a fragment of the protopodite of one uropod (ur. prptd).

An interrupted band of millet-seed siltstone particles marks the original course of the intestine (inf.).

Comparison with known forms. R. Siewing has recently listed most of the known fossil syncarids, but the following emendations are necessary to his 1959 account (pp. 100–3).

Synonymies of the genus *Uronectes* Bronn 1850 have been given by Cockerell (1916, p. 235), Haack (1927, pp. 773–4), van Straelen (1931, p. 18) and Calman (1934, p. 323). Siewing (p. 1) figures Fritsch's 1901 'restoration' of this genus but fails to take account of Calman's criticisms (1934, p. 321). Thus, there is no seventh abdominal segment (Haack 1927, pp. 775, 785; Calman 1934, p. 325, and cf. Tiegs and Manton 1958, p. 294). A specimen of *U. fimbriatus* (Jordan), in the Museum of Comparative Zoology, Harvard College (MCZ 6061), shows dorso-ventral wrinkling of the long sixth abdominal segment, probably caused by impaction of the telson. Fritsch's taf. 158, fig. 2, shows what is clearly a crack or fold in the last abdominal segment in the same position as the spurious boundary between the sixth and seventh abdominal segments on taf. 159 and fig. 377 (1901). Thus there is no evidence for a distinct Order Gampsonychidea Packard 1886 (cf. also Siewing 1955, p. 241; 1956, pp. 155, 159) based primarily on the presence of an extra abdominal segment. The genus *Uronectes* and the family *Uronectidae* Cockerell 1916 should be replaced in the suborder Anaspidacea Calman 1904, as shown by Calman (1934, pp. 322–3).

Palaeocaris scotica Peach 1881 was made the type of a new genus *Anthracocaris* of the ? Tanaidacea by Calman in 1933, and it and *P. landsboroughi* Peach 1908 should be removed from the Syncarida (cf. Siewing, p. 101).

The present specimen can be excluded from the genera *Uronectes* and *Acanthotelson* Meek and Worthen 1865, on the basis of the following characters:

A short fifth thoracic segment such as is present in this specimen is characteristic of both *Palaeocaris* and *Uronectes* (Calman 1911*b*, p. 490; 1934, p. 325; Haack 1927, p. 776) but not *Acanthotelson* (Meek and Worthen 1865, p. 48; 1866, p. 403). Further, *Acanthotelson* lacks thoracic tergal folds (Calman 1911*a*, p. 159), and has its sixth abdominal segment equal in length to the preceding segments (Meek and Worthen 1865, p. 48; 1866, p. 403, pl. 32, fig. 6; 1868, p. 549, figs. A, B; Calman 1911*a*, p. 159), whereas in both *Palaeocaris* and *Uronectes* this segment is always longer (Calman 1934, p. 325). The presence of an unmodified second or third thoracic pereiopod is significant, since *Uronectes* can only be distinguished from *Palaeocaris* 'by the enlargement of the second and third pairs of thoracic limbs' to form large raptorial appendages (Calman 1934, p. 329).

The genus *Triasocaris* Bill 1914 is distinguished by its large rostrum, and *Pleurocaris* Calman 1911 by its large thoracic tergal folds and transverse striation of the body segments. *Nectotelson* Brocchi 1880 is too poorly preserved to be distinguished from *Palaeocaris* or *Uronectes* (cf. Calman 1934, p. 323), and *Palaeorchestia* Zittel 1882 and *Belotelson* Packard 1886 are probably synonyms of *Palaeocaris*. The affinities of *Gasocaris* Fritsch 1901, from the Upper Westphalian of Czechoslovakia, are unknown.

The specimen most closely resembles *Palaeocaris retractata* Calman 1932. *P. vandergrachti* Pruvost, from the Namurian of Belgium, is very similar and agrees with the present specimen in showing an identically reduced first thoracic segment when compared with *P. praecursor* (Woodward), as figured by Calman (1911*b*, fig. 2A). Pruvost (1930, p. 182) suggested that this reduction was due to displacement of the first thoracic segment behind the second, but such unduly shallow first segments could also be explained by oblique instead of truly lateral flattening exposing more of the sternal region and less of the tergite. The lack of a counterpart to the present specimen prevents any certainty on this point, but the vertical displacement of the tergal folds on opposite

sides of the body, shown dotted on text-fig. 1, indicates that the specimen was flattened obliquely. The degree of incorporation of the first thoracic segment with the head is an important character in syncarid classification and phylogeny, as Calman has amply shown (1917, pp. 502–11). Should other syncarids be found possessing genuinely reduced first thoracic segments which can be shown to be not due merely to distortion, a new genus and family would be required.

In the absence of the telson and uropods the specimen cannot be distinguished from *P. lohesti* van Straelen. *P. praecursor* (Woodward) 1908 and *P. burnetti* Woodward 1881 show striae on the body segments, and *P. typus* Meek and Worthen 1865 is usually larger. These criteria are hardly sufficient for specific differentiation, however, and the three latter species are possibly synonymous (Calman 1911*b*, p. 492).

The five oval structures of the present specimen referred to as epipodites are identical with the four 'oblong depressed areas' at the bases of the last four thoracic limbs of *Palaeocaris praecursor*, described and figured by Calman (1932, fig. 2, p. 539). Although Calman was tempted to interpret these as branchial epipodites like those of modern *Anaspides* he was 'not inclined to attach much weight to it' in view of their fragility in the modern form (1932, p. 539). In 1934 he rejected this interpretation and suggested that they were 'only the side-plates (pleura [=tergal folds]) of the opposite side exposed owing to the somewhat oblique compression of the body' (p. 328). Although one must certainly agree with Calman's reservations, it still seems better to interpret these structures as epipodites. In the present specimen they are certainly not tergal folds of the opposite side and neither exopodites nor endopodites show such concave, oval structures. Epipodites (and exopodites) are wanting on the last thoracic limb of *Anaspides* and only reduced epipodites are present on the seventh pair (Calman 1896, p. 792). If the above interpretation is correct the fossil forms are noteworthy in possessing epipodites as well as exopodites (Calman 1932, p. 539) on this last thoracic segment.

P. ? cuylerensis Wells 1957 and *P. destinezi* van Straelen 1943 are Middle and Upper Devonian marine species. *P. novascotica* Copeland 1957, from the Lower Carboniferous of Canada, has only six thoracic segments (Copeland 1957, p. 596 and also kindly confirmed in a personal communication from Dr. Copeland) and thus is not a syncarid. It possibly belongs to Calman's genus *Anthracocaris*.

Occurrence. *P. ? cuylerensis*, *P. destinezi*, *P. lohesti*, *P. vandergrachti*, and *Clarkecaris brasilica* (Clarke) are the only syncarids known from supposedly marine beds; they are of Middle and Upper Devonian, Namurian, Lower Westphalian, and ? Lower Permian ages respectively. The known English syncarids and the majority of non-English syncarids are of Westphalian age, and are generally found in coal-measure ironstone concretions. The specimens of *P. praecursor* from Shipley Hall estate, Derbyshire, quoted by Calman (1932, p. 537) as 'Ouralian' [=Stephanian], were collected from below the Top Hard [=Barnsley] Coal (Moysey 1911, p. 506) and hence are of Westphalian age (see Stubblefield and Trotter 1957, pl. 1). *P. retractata* is known only from the Westphalian of Coseley, near Birmingham. Specimens were collected from 'binds between the Brooch and Thick coals' (Bolton 1921, p. 20), which is a little higher in the Middle Coal Measures than the Shipley locality.

The post-Westphalian fossil syncarids are *Nectotelson* [?=*Palaeocaris*] *rochei* Brocchi, from the 'Autunian' (Lower Permian) of France, *Uronectes fimbriatus* (Jordan), and

Clarkecaris brasilica (Clarke), from the Lower Permian of Saarland and Brazil, and *Triasocaris peachi* Bill, from the Triassic Bunter sandstone of Alsace. *Anaspides* (?) *antiquus* Chilton 1929, from the Triassic Hawkesbury Sandstones of New South Wales, is presumably to be included in one of the foregoing genera.

The Keele redbeds are almost certainly of primary origin (Trotter 1953, p. 18), and their conditions of deposition have been fully discussed by Wills (1948, pp. 56–64). We may perhaps imagine the present specimen inhabiting a temporary fresh-water pool in the south of the Keele redbed playa portrayed by Wills (1956, fig. 10, p. 77). Professor Wills's record of arthropod trails from the Keele Beds (1948, p. 63) is relevant to the present discussion, and an unpublished photograph by Dr. Raw (No. 174 in the Birmingham collection) shows a trail of the type of *Ichnispica* Linck 1945, with the paired tracks 6–13 mm. apart. The smaller trails could conceivably have been left by a crustacean of the size of the present specimen.

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ADDENDUM

While this paper was in press, A. Vandenberghe's paper appeared (1961, *Bull. Soc. géol. Fr.* 2, 5, 690–2) demonstrating the syncarid nature of the previously doubtful genus *Eileticus*. *Eileticus* is a member of the family Pleurocarididae Chappuis 1915 [= Acanthotelsonidae Pruvost 1919; Eileticidae Vandenberghe 1961] which is distinguished from the Palaeocarididae by having the first thoracic segment incorporated with the head. The two subfamilies proposed by Vandenberghe require changes, thus: Pleurocaridinae [*nom. transl. et correct.* herein (*ex* Pleurocarididae Chappuis 1915)] [= Acanthotelsonidae Vandenberghe 1961]; Eileticinae [*nom. transl.* herein (*ex* Eileticidae Vandenberghe 1961)] [= Anacanthotelsonidae Vandenberghe 1961 (*nom. nud.*)]. Vandenberghe states that *Eileticus* has a seventh abdominal segment, although by analogy with *Uronectes* this appearance may solely be due to the extra length of the sixth segment. In either case this would provide a further distinction from the Pleurocaridinae; the nature of the head, together with the absence of limbs from the described specimens, prevents closer comparison with the Uronectidae.

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